THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Spiral Spring Process Model (SSPM) for Policy Making and Implementation Engineering in Ministries, Departments and Agencies (MDAS)

Jonathan Chukwuemerie Uzoh
Ph.D. Student, University of Nigeria Nsukka, Enugu, Nigeria
H. C. Inyiama
Supervisor & Professor, Nnamdi Azikiwe University, Awka, Anambra, Nigeria

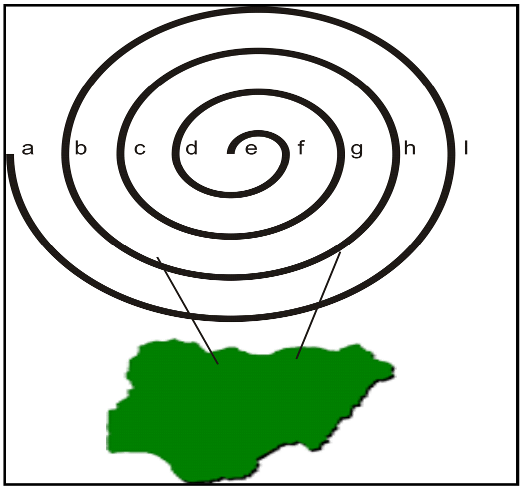
Abstract:
Spiral spring process model (SSPM) is a model developed in the course of developing a people-centred information management resource (IRM) tool for the public sector in Nigeria as well as the developing nations. It has an elastic limit beyond which it can break if its elasticity limit is exceeded without reassessment. This model is a tool for planning continuity in order to meet future demands. Modeling a society using SSPM by MDAs involves continuous evaluating and reevaluating of MDAs functional activities, policy-making, and continuity of vision, mission and circles of development of systems capacity to hold a growing workforce or population. SSPM is an economic management tool for managing a growing or developing population. The tool's variability may be used for a growing or developing system. It involves different layers of concentric circles transforming into springs that has a potential capacity for holding a developing system and can be used as a forecasting instrument and information management tool for strategic planning.

Keywords: *SSPM, IRM Tool, MDAs, Elastic limit, Policy-making and functional activities.*

1. Introduction

Spiral spring process model (SSPM) is a tool of variable concentric circles designed to assume capacity of a growing system over a period or range of time. This tool represents the capacity of a system as time increases. The difference between the 1st circle and the 2nd is that the 2nd is a cumulative of the 1st and the 2nd. For example, if the 1st is of length 2cm and the 2nd is increased with 1cm. Therefore, the 1st is 2cm while the 2nd will be 3cm. The model is spiral because it is a developing concentric circle which is circles of planning, decision-making and implementation. It is a spring because it has a potential energy of carrying the system growing population or workforce that it was built for over a period of time.

The Spiral spring process model (SSPM) was developed in this research for the IRM Tool in the MDAs functional activities. It has a potential energy of holding a system or managing the work done in a system. If the work done is more than what the system can hold, then the spiral spring is expected to pass its elastic limit, then crashes. The maximum capacity of the system is the elastic limit of that system. This system is built for policies and functions of the MDAs. As the system population or workforce increases, the stress and strain of the system are affected as well. It is expected that the MDAs need to reevaluate the policy or mandate so as to know if the system output can be managed by the system. This in turn produces a spiral spring model movement in the system. The entire spiral spring process model is a collection of assumed quantities (L) and time (t). Policies or mandate are made or carried out within time frames. All these functional quantities produces data, which is processed into information which produces mission and vision which are put into play to deliver output in the society. After processes of time, the population increases with time, thereby policy or mandate needs evaluation and reassessment because if the population (workforce) is allowed to outgrow the strength of the existing system or infrastructure, this might lead to system collapse or crashing. This demands fresh mandate or restructuring of policy to maintain the same vision in order to build an open system to carry the ever increasing workload of the growing workforce or population. Considering the spiral spring diagram in figs 1. A & b below, a mathematical presentation model for MDAs and other organization to carry out their mandate and functions is hereby formulated.



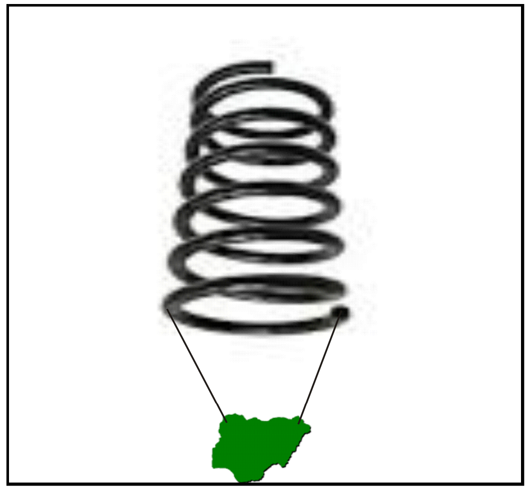


Figure 1a: Spiral Spring Process Model (SSPM) for MDAs Figure 1b

The period, assumed quantities of the entire functional activities in the spiral spring model, resources and the entire processes (improvement on the system) in totality is termed the capacity of the system (L).

In physics a spring is an elastic material used to store mechanical energy usually made out of steel. While a Spiral is a curve in the plane or in the space, which runs around a centre in a special way that can be observed in anything from a roll of tape to the shape of our galaxy.

A spiral spring model (SSPM) is an approach with a potential capacity to manage a real world policy and infrastructural analysis, design, and implementation for a growing work force or population. This approach is basically made to take care of both a closed and open systems. It is spiral because it is developed through series of concentric circles and spring because the approach is elastic.

2. Postulated Theory

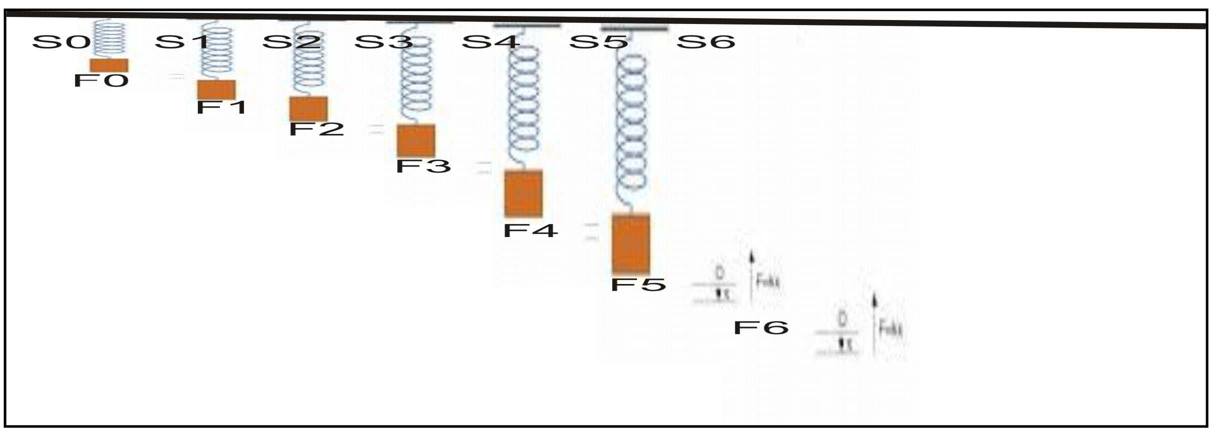


Figure 2: A fixed SSPM with variable workforce

S is the spiral spring representing the given system

F is the workforce at different states of the given system

So and Fo are the initial states of the given system and the workforce or wprkload respectively.

At So, the spiral spring of the existing system has eight concentric circle which represents eight different times that policy has been made and implemented by the MDA, meaning that its value has been increased eight consecutive times. That is, at the eight consecutive times, the system has been reevaluated and its potential has been increased to carry a better load or workforce.

The system (S) at So has Fo (i.e no load). In this case, the potential energy of the system is intact. No workdone and No workforce.

At S1, the workforce F1 is loaded on the system (S). The system is stretched. The more the workdone (F2,F3, … n) in the consecutive (S2,S3, … n), the more the system is stretched up. If the system (S) gets to its elastic limit and no enhancement was done to increase the system capacity to manage the growing workforce, it will eventually crash.

The main aim of the SSPM is to help the MDAs make policies and implement them and enable their system to have a larger potential energy in order to carry the growing workforce over time and not get to an elastic limit talkless of breaking point.

Fig.2: depicts a fixed SSPM with variable workforce weight used to illustrate the postulated theory.

2.1. The Theories

(1) The workforce limit depends on the number of coils (n). i.e F∝n

⇒ F = cn, c = workforce constant (the ratio of population using the system to the number of times value is added on the system)

(2) The workforce limit increases as the capacity of the system (L) increases.

(3) The workforce of any given society increases exponentially.

(4) In a spiral spring process model (SSPM), the latter coils must be larger than the earlier coils.

So many objects take on a spiral shape; it is useful to know how to calculate the length of this type of curve. In this regard, definite line integral will be used to calculate the length of our spiral model in this research work. Fig.3 is a sample graph from the expected output of the SSPM.

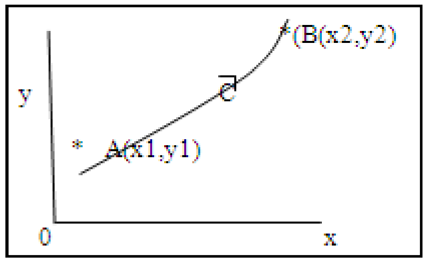


Figure 3: A graph from the output of SSPM

y = f(x), A & B are as shown (closed system – 2 dimensional)

If p(x,y), Q(x,y) are two real single-valued functions of x and y at point of c, the integrals

$\int_c P(x,y)dx, \int_c Q(x,y)dy,$ ………………. (1)

and more importantly, the integral

$\int_c \{P(x,y)dx + Q(x,y)dy\}$ ………………… (2)

are called the line integral, the path of integration C being along curve y = F (x), from A to B. Since y = f(x), each of these integrals is equivalent to an ordinary integral w.r. to x or y. N/B: c ranges b/w X1 to X2

if we represent{p(x,y)+Q(x,y)}dy in equation (2) with L, we have

$\int_c L\, dL$ ………………………………………… (3)

In particular with reference to our research work model (SSPM), functions of y with respect to x will not be integrated with the assumption that z, the third dimension, does not change rather the function will be integrated based on the fact that the dimension does change, the line is not linear and there is no way to integrate with respect to one variable. A line integral takes two dimensions, combines it into s, which is the sum of all the arc length that the line makes, and then integrates the functions of x and y over the line s.

If we have a function defined on a curve we can break up the curve into tiny line segments, multiply the length of the line segments by the function value on the segment and add up all the products. Of course, we will take a limit as the length of the line segments approaches zero. This new quantity is called the line integral and can be defined in two, three, or higher dimensions. Suppose that a string (spring) wire has a density f(x,y,z) at the point (x,y,z) on the wire. Then the line integral will equal the total mass of the wire. Below is the definition in symbols.

$\int_c f(x,y)ds = \lim_{n\to\infty} \sum_{i=1}^{n} f(xi,yi)\Delta si$ (for two dimensions) ------------------ 4

$\int_c f(x,y,z)ds = \lim_{n\to\infty} \sum_{i=1}^{n} f(xi,yi,zi)\Delta si$ (for three dimensions) ------------ 5

This research work is based on scalar quantity and a scalar field has a value associated to each point in space. Examples of scalar fields in our research work are manpower, time, financial capacity, policy making, vision, design, implementation, evaluation and reassessment of policies.

So a line integral is the sum of the arclength multiplied by the value at that point. The main application of line integrals is finding the work done (W) on an object in a force field. If an object is moving along a curve through a force field, F, then we can calculate the total work done by the force field by cutting the curve up into tiny pieces. The work done (W) along each piece will be approximately equal to

Workforce (F) ∝L

i.e F∝L

∴ F = KL, where K is a constant ----------------- 6

Workdone (W) = F x L

Since L is function of F

∴ W = $\int F\, dL$

Since F = KL

$\Rightarrow W = \int KL\, dL$ -------------------------------------- 7

$\therefore W = 1/2KL^2$ - In this case, this is a closed system as shown in fig.4, but here, we are dealing with an open system and as such we will be using $W = \int F\, dL = \int KL\, dL$ since policy formulation and functional activities are not constant but dynamic. Since the constant term k cancels out in the subsequent calculation, our work done becomes

$W = \int L\, dL$ -- 8

= Close system. Workforce is constant

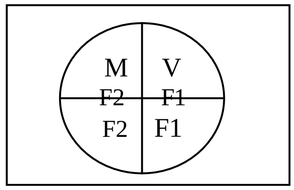


Figure 4: A closed system

Note: Quantities in the Spiral Spring Model is as defined by the Psycometricians (Evaluation and Measurement Experts).
The model developed in this research work is based on virtual space and in order to determine or calculate the length (L) of the spiral spring model, we will use the vector analysis formula to calculate the arc length in space (L). Vector analysis is a branch of mathematics concerned with differentiation and integration of vector fields, in particular in 3-dimensional Euclidean space. The term 'vector calculus' is sometimes used as a synonym for the broader subject of multivariable calculus. It is used extensively in Physics and Engineering purposes. The highlights of vector analysis are found in Green's Theorem, Stoke's Theorem and the Divergence Theorem, Murray R. Spiegel (1974).

2.2. Arc Length in Space

The best way to visualize the arc length of a curve is to think of the curve being a piece of string (spring), and then taking that spring and extending it out until it becomes a line (figs.5a &b), which you can then take and measure along a ruler to find the curve's arc length. Since the curve cannot be measured that way, another method must be used – Mathematical method.

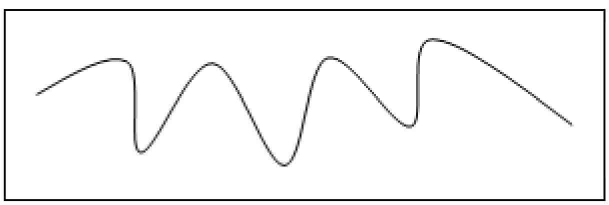


Figure 5a: String (Spring)

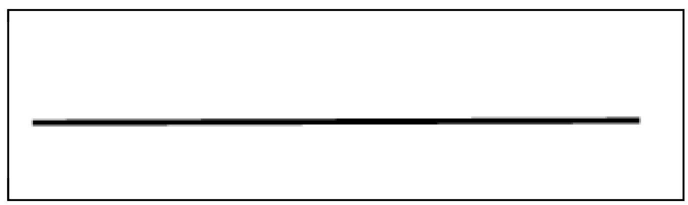


Figure 5b: Straight line

We already know how to find the arc length of a curve r(t) = x(t)i+y(t)j in a XY-plane for $a \le t \le b$, equations 1&2. The formula is given as

L = ∫_a^b▒√((dx/dt)^2)+(dy/dt)^2 dt which is a closed system (2-dimensional array)

We are now going to calculate an arc length in space rather than in just a plane which we called open space (3-dimensional array)

2.3. Arc Length along a Space Curve

Calculating the arc length for a curve in space is very similar to calculating the arc length for a curve in the plane. All we need to do is add a z-term to the formula for the arc length of a plane curve.

So the length of a parameterized curve in space r(t) = x(t)i + y(t)j + z(t)k from $a \le t \le b$ is

$L = \int_a^b \sqrt{\left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2 + \left(\frac{dz}{dt}\right)^2}\; dt$ -------------------------------------- 9

From there, we see that the $\sqrt{\left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2 + \left(\frac{dz}{dt}\right)^2}$ term is just the magnitude of v(t), the length of the velocity $\left(\frac{dr}{dt}\right)$. So we can rewrite the arc length formula equation (9) to be

$L = \int_a^b \sqrt{|v| dt}$

2.4. Important Points to Note

Definite line integral with limits are being considered in this research work which implies dealing with limited resources and time. An integral with limits is called a definite integral. With a definite integral, the constant of integration may be omitted not because it is not there, but because it occurs in both brackets and disappears in subsequent working.

So, to evaluate a definite integral

a. Integrate the function (omitting the constant integration) and enclose within square brackets with the limits at the right-hand
b. Substitute the upper limit

c. Substitute the lower limit
d. Subtract the lower limit from the upper limit

The following assumptions are made:-

a. Infrastructure with an ability to hold or carry a growing system which involves manpower, time, financial capacity, policy making, vision, design, implementation, evaluation and reassessment of policies.
b. Capacity of infrastructure (L)
c. Workforce or growing population (F)
d. Work to be done (W)

Let's illustrate SSPM with hypothetical values of activities of MDAs.

A consultant is hired to design an SSPM for a country population that was 37,000,000 in 2010 and the infrastructure capacity for 1000 people was estimated at 3000tons. What amount of infrastructure can take care of the population in 2025 assuming $4000 can take care of the infrastructure of 1000 people if the rate of population growth is 5%. Using the Population Geometrical function: Xt = x0(1+r)^t

2.5. Solution

Year	Xi (conc.cycles)	Estimated population (Xt)	rate	Increase rate		estimated capacity(L/ton)	estimated budget assuming global economy is constant	COMMENT		
2010	x0	37,000,000	0.05			67,000,000		IT IS NOT MEETING 2010 TARGET		
2011	x1	40792500	1.05	1.1025		122377500				
2012	x2	49358925	1.1	1.21		148076775				
2013	x3	65277178.31	1.15	1.3225		195831534.9				
2014	x4	93999136.77	1.2	1.44		281997410.3				
2015	x5	146873651.2	1.25	1.5625		440620953.6				
2016	x6	248216470.5	1.3	1.69		744649411.6				
2017	x7	452374517.5	1.35	1.8225		1357123553				
2018	x8	886654054.4	1.4	1.96		2659962163				
2019	x9	1864190149	1.45	2.1025		5592570448				
2020	x10	4194427836	1.5	2.25		12583283508				
2021	x11	10077112876	1.55	2.4025		30231338628				
2022	x12	25797408963	1.6	2.56		77392226889				
2023	x13	70233445901	1.65	2.7225		2.107E+11				
2024	x14	2.02975E+11	1.7	2.89		6.08924E+11				
2025	x15	6.2161E+11	1.75	3.0625		1.86483E+12				
					∫L dL=	2,816,271,048,840				
	Population Geometrical function: Xt = x0(1+r)^t									

Table 1

Between 2010 to 2015 (n=15) which means there is a need for 15 revolutions of 15 circles

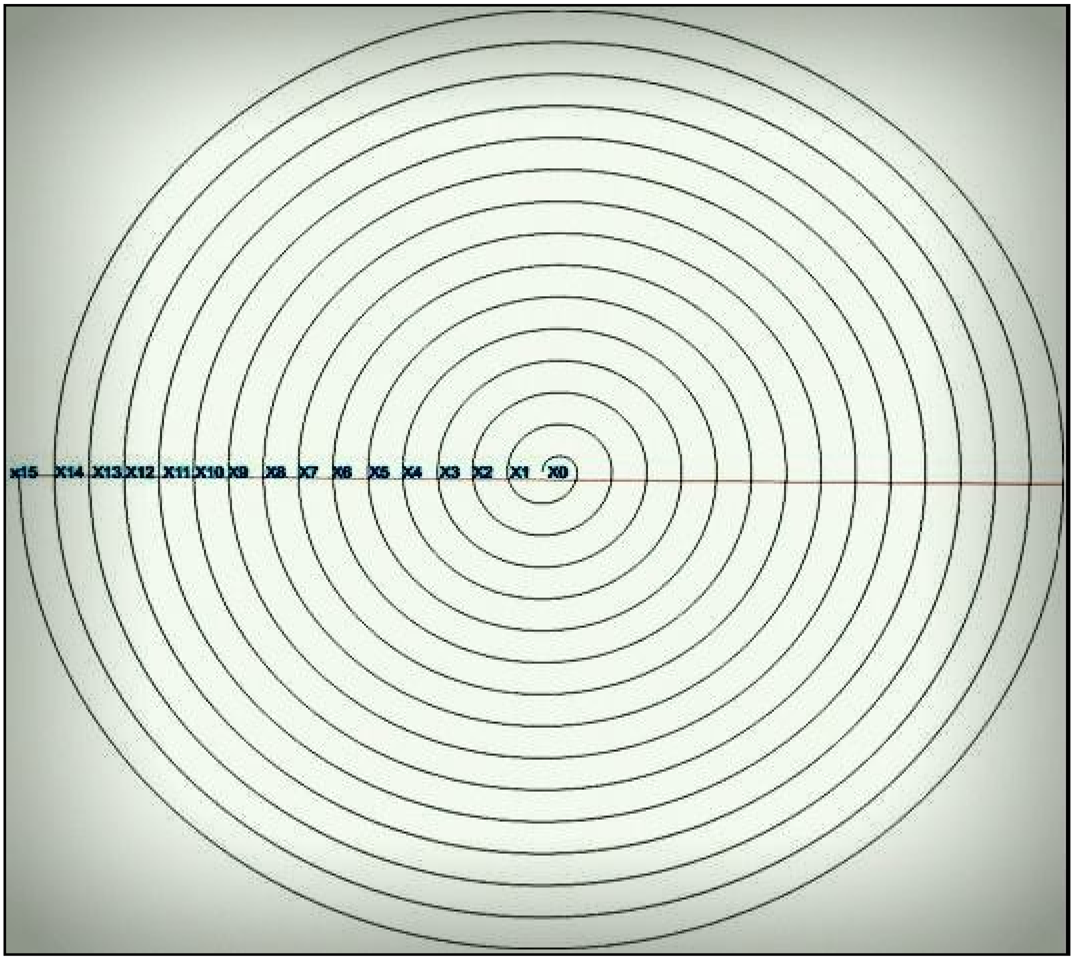


Figure 6

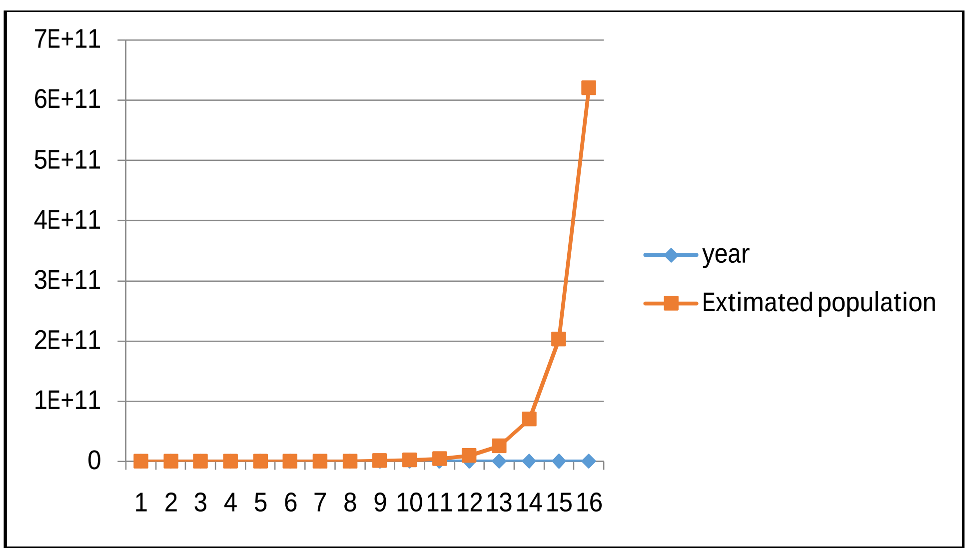


Figure 7: Graph showing population growth within 15 years following a geometric function.

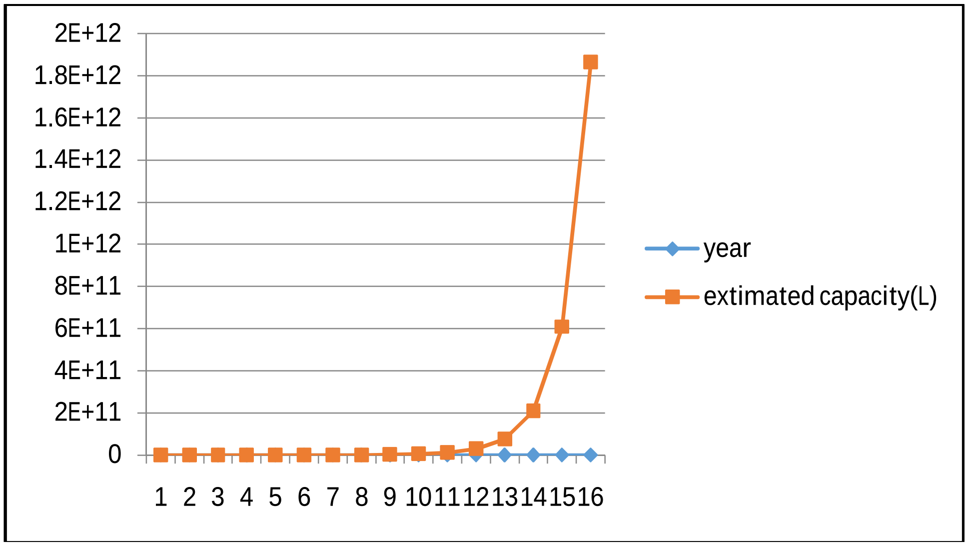


Figure 8: Graph showing estimated Capacity to carry the estimated population.

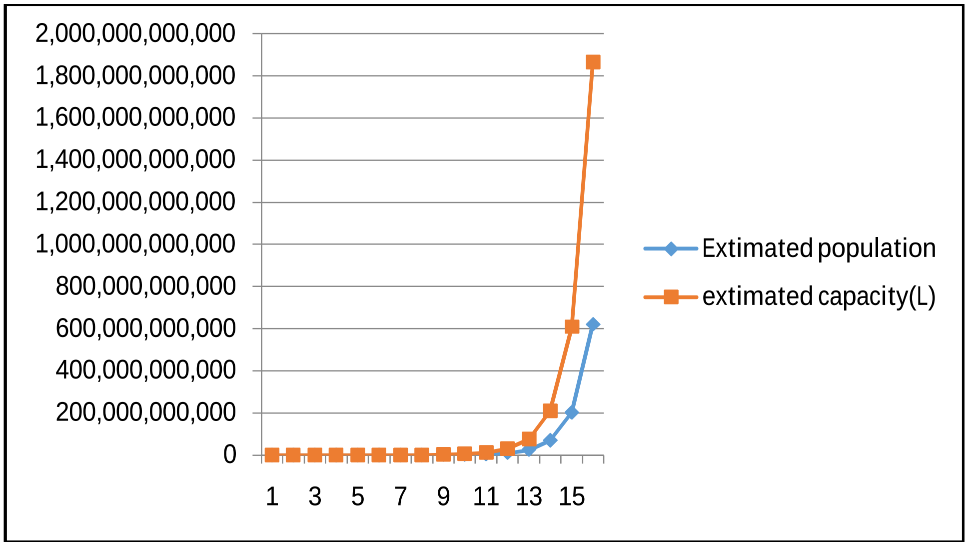


Figure 9

Graph demonstrating the above SSPM showing that the estimated capacity for 2025 can be able to carry the estimated population from 2011 to the next 14 years. It is expected that policy makers revisit the model to actualize their annual targets.

Traditional management theory literature says that people satisfaction and loyalty can be achieved if the people can recognize the value proposition and perceive a particular offering as meeting his/her current and/ or latent requirements. The value proposition has to do with the product/service itself as well as with the delivery channel and in this research, both value proposition is pursued. Governmental projects must be designed around the citizen needs as though they were to be operated by the people themselves.

To build people-centred information systems, technology innovations presuppose an organizational ‘’shake up’’ so that business processes get streamlined and people value-driven operations are established but in this research MDAs shake up is not being looked into rather to develop an IRM Tool that will make citizen get satisfaction and quality services from the MDAs.

3. Conclusion

Using the SSPM by the MDAs to evaluate and reevaluation of their policies, decision-making and implementation processes will help them serve the populace better. Furthermore, it will help maintain a steady flow of information system that will be up-to-date for continuous improvement on the system at anytime thereby keeping the system capacity building infrastructure of the workforce in equilibrium always throughout the systems life cycle.

Therefore, the SSPM is a systematic IRM tool needed by the MDAs in Nigeria and other developing nations to manage a growing workforce and as a forecasting instrument and information management tool for strategic capacity building for the future.

4. Reference

i. Murray R. Spiegel (1974). Theory and problem of Vector Analysis, SI (Metric) edition. An introduction to Tensor Analysis, McGraw-HILL Book Comppany, 1974, pp.82-134